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Geochemical Characterization of Soils and Groundwater Occurring within the Shallow Subsurface Zones in parts of the Interfluves between Burhi Dihing and Noa Dihing rivers, Assam.

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ABSTRACT

The geochemical status of ground water and soil of the part of the terrain between Noa Dihing and Burhi Dihing rivers bounded by longitudes 95°0' E and 96°0' E and latitudes 27°0' N and 28°0' N of Dibrugarh and Tinsukia districts of Assam have been studied and tried to find out any correlation, if any, between them. Samples were collected from seventeen sites in order to assess the geochemical status and the major natural and manmade changes in the region. The physical, chemical, and engineering parameters of soil viz. permeability, bulk density, porosity, pH, conductivity, micronutrient contents, total soluble salts, acid insoluble, etc. were determined, while in case of groundwater chemical analyses were carried out in order to assess the hydrogeochemical quality. To get a preliminary idea of depositional history, geochemical analysis of soil samples of various depths from four locations were carried out.X-ray diffractional studies of the clay samples indicated that clay samples are mainly kaolinite mixed with halloysite and impurities like quartz and calcite. The results revealed that soil and groundwater geochemistry is influenced mainly by natural processes such as geological background, weathering of prevailing geological formation together with impacts deriving from the extended cultivation.

Keywords: Geochemical characterization, shallow subsurface, groundwater quality, x-ray diffraction, TDS, SAR.

INTRODUCTION

Subsurface is the sustainer of all types of lives, as ecology, agriculture and everything depend on the condition of subsurface soil and groundwater. Soil is the essential medium for the basic needs of human beings in every aspect, helping the various demands of modern civilization. The knowledge of subsurface soil and

groundwater is necessary for any future developmental project. Clay mineralogical information of soil is essential for better management practices for the soil and for understanding of their geological and engineering properties, which are dependent on their geochemical and physico-chemical parameters.

Increasing human population, its greed and its urbanization have increased the land use pattern and land use density. Thus, through the centuries, the nature of the surface and subsurface soil are going on changing due to the anthropogenic causes. Similarly the limited water resources have been overused/ misused by the ever increasing population of the country.

The Brahmaputra valley in Assam comprises an area of approximately 3000 km^2 and the present area of investigation being a small part bounded between latitudes $27^0\ 0^/$ N and $28^0\ 0^/$ N and longitudes $95^0\ 0^/$ E and $96^0\ 0^/$ E, extends from the Brahmaputra River in the north to the foothills of Naga-Patkai hills in the south. The eastern boundary is in the apex of the Diyun River and the western boundary is limited to the river Burhi Dihing (**Fig. 1**). The area is comprised of parts of three river basins: the Noa Dihing, Dibru, and Burhi Dihing. The topmost part of the soil of the area was probably deposited from the great alluvium of the river Diyun. The study of the subsurface soil of this area and geochemical data may be of use in monitoring the changes occurring in the land and also will be helpful in the development project to be undertaken in future.

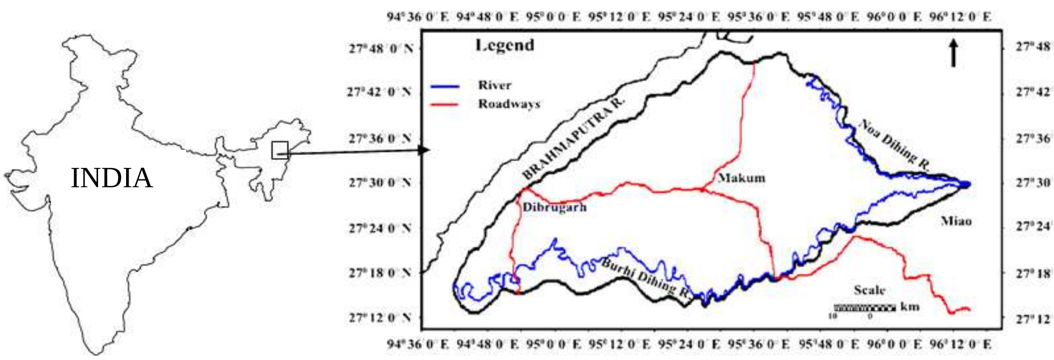


Fig 1: Location Map of the study area

METHODS

Seventeen samples of soil (**Fig. 2**) and similar number of samples of groundwater (**Fig. 3**) were collected during three field visits (Feb-March 2008). Soils were collected from within one metre range from the ground surface and groundwater samples were collected from dug wells.

Soil pH (soil : water = 1 : 2.5) was determined pH-metrically using Consort nV pH-meter, Model C830. Electrical conductivity of soil was determined conductometrically using conductivity meter Elico, CM180. Loss on ignition of the soil samples was determined using muffle furnace model LEF-1035, Daihan Labtech Co. Ltd. Thermogravimetric analysis of some soil samples was done by using Perkin Elmer DTA-TGA. Organic carbon content was determined by volumetric method of titration with ferrous ammonium sulphate. The total soluble solute (TSS) and acid

insolubles were determined as per standard methods[1]. The amount of calcium and magnesium were determined volumetrically using standard EDTA solution while iron (as sesquioxides) and aluminium (as oxinate) were determined gravimetrically following standard methods[2]. Sodium and potassium was determined using photoflame flame photometer, dual channels, PEI (Aimil India Ltd.). Of the physico-chemical properties, texture was determined by international pipette method and bulk density, particle density, pore space were determined by methods reported elsewhere [1]. Permeability of the soil samples were determined by using constant head (15 cm) permeameter and stop watch [2].

In case of groundwater pH and electrical conductivity (EC) were determined as in case of the soil samples. Total dissolved solids (TDS) was determined gravimetrically. Various ionic species such as chloride, carbonate, bicarbonate, calcium, magnesium were determined by usual analytical method[2]. Sodium and Potassium were determined flamephotometrically. From the data obtained, sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were determined using standard formulae.

XRD studies of randomly selected four clay samples were carried out using a X-Ray diffractogarm model Ultima IV, make Ringaku, Japan, using Cu Kα Radiation (40kV,40 mA), scan speed 2.0000 deg/min, sampling speed 0.0200 deg., scan range 4.000 to 70.000 deg. at Material Science Division, NEIST, Jorhat, Assam.

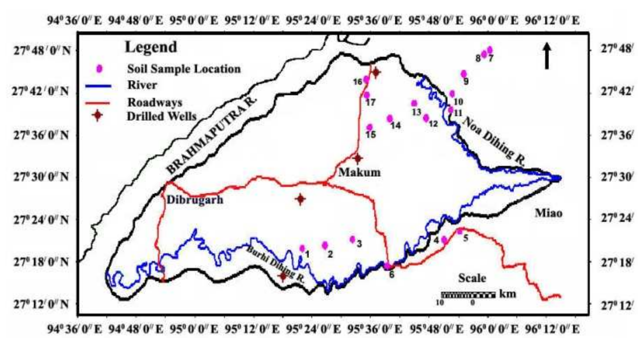


Fig 2: Location map of Soil samples.

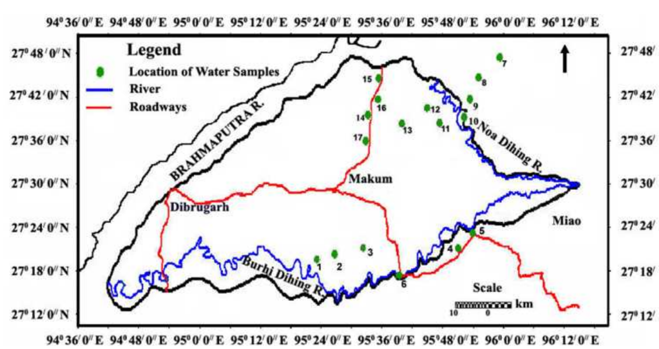


Fig 3: Location map of groundwater samples

RESULTS AND DISCUSSIONS

Geochemical Characterization of Soil

Interpretation from permeability data:

The permeability co-efficient of a soil mass is utilized to predict the discharge through it. In general more the clay contents of soil, the lesser is the permeability. The physical parameters and geochemical characteristics of soils of the area are presented in the **Table 1** and **Table 2** respectively. The hydraulic conductivity of soil refers to the readiness with which it transmits water. This property of soil is of great importance as it affects the drainage rate, trafficability and perhaps infiltration of water.

In the southern part of the terrain as one moves towards river Burhi Dihing finer soils are encountered. The clay contents are more in the soil samples collected from near the Burhi Dihing (around Margherita, 1No. Rongagora, Udaipur etc.). Here the permeability values are low, aquifers are likely to be poorly recharged, indicating reductive condition[3].

In the northeastern part of the terrain the relative permeability values are high (Namsai, Nabajyoti, Lajum, Nanam Budha Vihar etc.) near the river Noa Dihing indicating easy recharging of the aquifers, good draining facilities and oxidative condition. This is probably due to sandy patches of the soil occurring near the river Noa Dihing [4]. As these areas fall within the upper reaches of the Noa Dihing and other smaller rivers, the relatively high energy conditions of the river regime are probably responsible for carrying the finer particles towards further downstream direction, leaving the relatively coarser fraction of sediments get deposited in that part of the area.

Soils near Brahmaputra have low permeability value (around Dhola, Horu Dhadum).

Particle density and Bulk density: The air-liquid-solid volume relationship can be expressed in terms of particle density and bulk density. Air and water spaces vary reciprocally with moisture content of the soil and are indirectly dependent on the texture and structure. In the southern part of the terrain the relatively low bulk density (around Margherita, Jagun, Digboi, Rongagora) and higher pore space value indicate better aeration capacity of the soil, whereas in the north-eastern part most of the soil samples have high values of bulk density and relatively lower values of pore space (around Lajum, Nabajyoti, Namsai, Chowkham-2), hence may have poor aeration capacity.

Pore space and Texture: Most of the soil near Burhi Dihing (in the southern part, Margherita, Rongagora, Udaipur, Jagun) and near river Brahmaputra (around Dhola, Horu Dhadum) contains higher percentage of clays, having 40%–50% pore space and are mainly characterized by loam or clay-loam textures. In the north-eastern part of the terrain most of the soils show sandy loam textures (around Amguri, Momong, Lathau etc.) having 65%-85% sand with pore space of 30%-40%.

pH: Soils of southern part of the terrain are found to be more acidic near the Burhi Dihing, river having pH in the range 3.5 – 4.5 which is probably due to greater content of humic acid (greater organic carbon

content). Other probable reasons of grater acidity may be human habitation and cultivation. In the northern part, soils are less acidic having pH in the range 4.5 – 6.5 (low organic carbon content) showing probably low presence of humic acid [5].

Electrical conductivity and major cations:

Almost all the soils show variable electrical conductivity and hence concentration of exchangable ions. The amount of major cations varies within their optimum limits and X-ray diffraction studies show multivarient mineral contents.

Geochemical Characterization of Soils of Various Depths:

In order to have a preliminary idea about the depositional history of the area, drill hole soil samples of various depths were collected from four drilled hole sites i.e. Dhola, Chota Tingrai, Naharkatia and Doomdooma (**Fig 2**) and their geochemical characterization are shown in **Tables 3, 4, 5 and 6.** Of the five soil samples of various depths at Dhola, it was found that the subsurface soil is acidic and pH increases with depth, indicating acidic nature of the deposits in the flood plains adjacent to river Lohit and Sub-Himalayan foothills. Loss on ignition decrease with depth as well as amount of Fe, Al, Ca, Mg and Na content. The average bulk density and particle density value were ~1.5and ~2.27 g/ml respectively while the pore space values were within the range of 31-45%.The amount of usual cations were found to be minimum from the depth of 2700 cm while relatively higher percentage of cations in the upper layers (660-1440 cm) is probably due to new deposits. The variation of mineral contents with depth could be an indicator of extent of weathering of the prevailing geological formation.

The samples of Chota Tingrai showed a little wider variation in pH values, more acidic soils were encountered at the depth of 92 cm and 2025 cm with corresponding higher loss on ignition and lower amounts of acid insolubles. At a depth of 5122 cm the particle density and bulk density value were quite high (4.00 and 2.0 g/ml) while pore space were within the range of 28-57%.

The subsurface soils of Naharkatia and Doomdooma were acidic (pH ~4.4 -4.2) which could be due to increase in human population in these two urban centres during last fifty years. However, with the increase in depth the pH increases towards neutral value. In the case of Naharkatia soil, acid insoluble increases with depth and loss on ignition decreases. Like the soils of Chota Tingrai, here too, there was wide variation in the pore space percentage (30.76 -53.85%) with depth.

X-Ray Diffraction Studies of Clay Samples:

The X- Ray diffraction studies of four clay samples (1 No Rongagora, Dhola, Horu Dhadum, Margherita) were carried out. From the diffractogram the classification of clay were made according to the scheme recommended by the “Nomenclature of the clay minerals society”. X-Ray diffractograms, clay photographs and DTA of some of the soil samples are presented in **Figs. 4, 5** and **6** respectively.

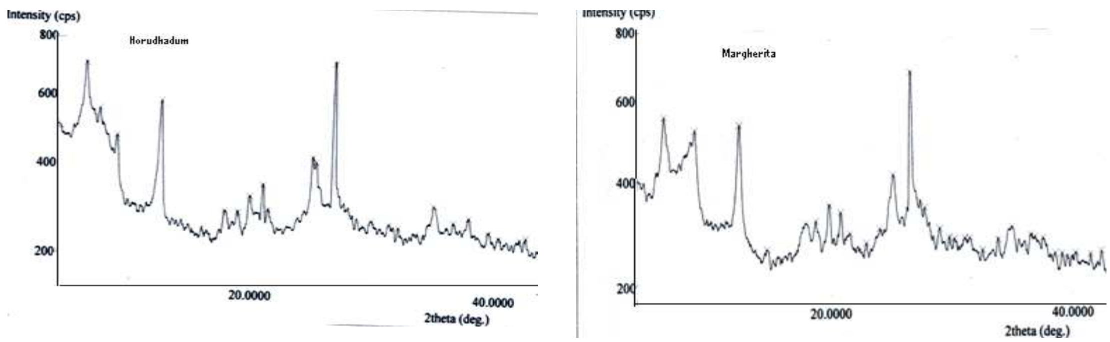
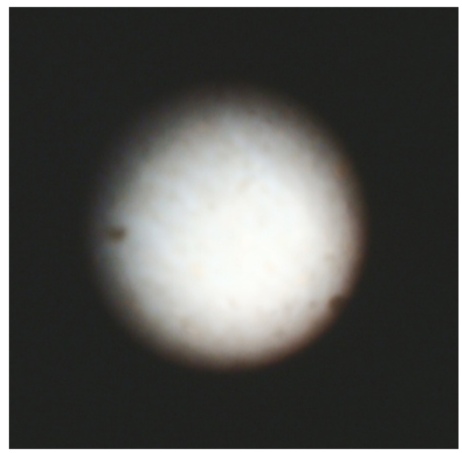


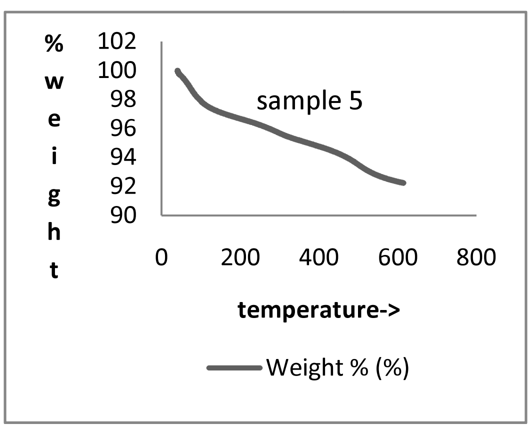
Fig. 4: X-Ray difractogram of clay samples of Horu Dhadum and Margherita

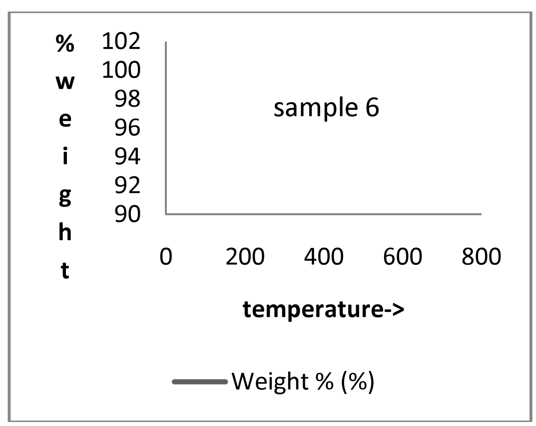
(A)



(B)

Fig. 5: Clay Photograph of soil samples from Dhola before (A) and after (B) deferration





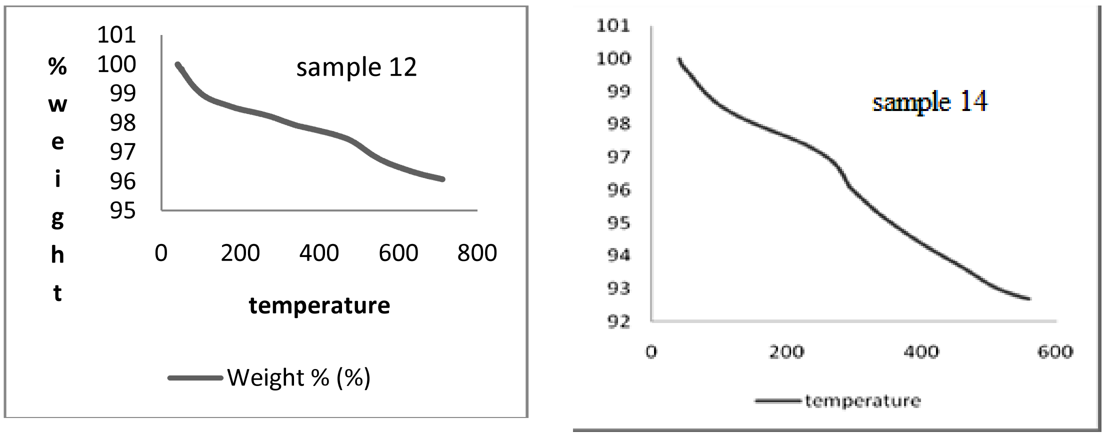


Fig. 6: DTA of some randomly selected soil samples from the area

The clay separated from soil of 1 No. Rongagora, Margherita and Horu Dhadum areas mainly contain Halloysite clay which belongs to Kaolinite group of clay. Soil of Dhola contains Halloysite along with Kaolinite. From the diffractogram studies it was found that soil of 1 No. Rongagora also contains high amounts of calcite and quartz. The presence of feldspar, muscovites were observed. It also contains traces of hematite, siderite, pyrite and goethite.The clay separated from the soil of Margherita is mainly Kaolinite and contains high amounts of quartz and calcite, also contains both feldspar and muscovite. A trace of pyrite is also presents. Similarly the clay obtained from the soil of Horu Dhadum contains high amounts of quartz and calcite along with Kaolinite as the predominant mineral. Muscovite and goethite are also presents. Other trace minerals are siderite and pyrite.

Geochemical Characterization of Water:

Various elements may be present in ground water and their mineral content varies from aquifer to aquifer and from place to place within an aquifer. For this reason it would not be practical to discuss them other than in generalization. The chemical analysis data of water samples of the area are presented in Table 7.

The pH is one of the most important attributes of any aquatic system since all the biochemical activities depend on pH of the surrounding medium. It is also established that the pH of the natural water is controlled to a greater extent by interaction of hydroxyl ion arising from the hydrolysis of bicarbonates. The chemical analysis data of the groundwater samples collected from the area of study show that the pH is in the range of 6.46 to 8.67 indicating an alkaline nature. The total dissolved solids (TDS) contents ranging between 100 mg/l to 400 mg/l indicate that the groundwater is more or less suitable for drinking purpose.

Regarding suitability of water for irrigation purpose, the evaluation of parameters like electrical conductance (EC), sodium hazards (SH), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) are essential. Low EC value of the ground water ranging between 38.02 μmho/cm and 446.3 μmho/cm places the ground water of the area in the “Excellent”

to "Good" class [6]. The Ground water of the area is characterized by low concentration of sodium, which reduces the sodium hazard. A high concentration of Na in ground water is responsible for deflocculation of clay-sized/colloidal particles, which reduce the permeability of the soil. The sodium adsorption ratio (SAR), the relative abundance of Na in relation to other cations in ground water is studied by calculating the SAR value (in meq/l) using the formula [6]:

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{+2} + Mg^{+2})/2}}$$

A lower value of SAR is desirable in irrigation water and the SAR value in the present case ranging between 30.7 x 10^{-3} meq/l and 1.89 meq/l indicates that ground water of the area are suitable for irrigation.

When the sum of carbonate and bicarbonate is in excess of calcium and magnesium, there occurs a complete precipitation.

$$RSC\ (meq/l) = (CO_3^{-2} + HCO_3^{-}) - (Ca^{+2} + Mg^{+2})$$

RSC value less than 1.25 meq/l is safe for irrigation, between 1.25 and 2.5 meq/l are of marginal quality, while more than 2.5 meq/l are unsuitable for use in agriculture [7, 8]. Only one sample (Sl. No.10 – Namsai) is found to unsuitable for higher value of RSC, three samples are of marginal quality while the rest are safe for use in irrigation.

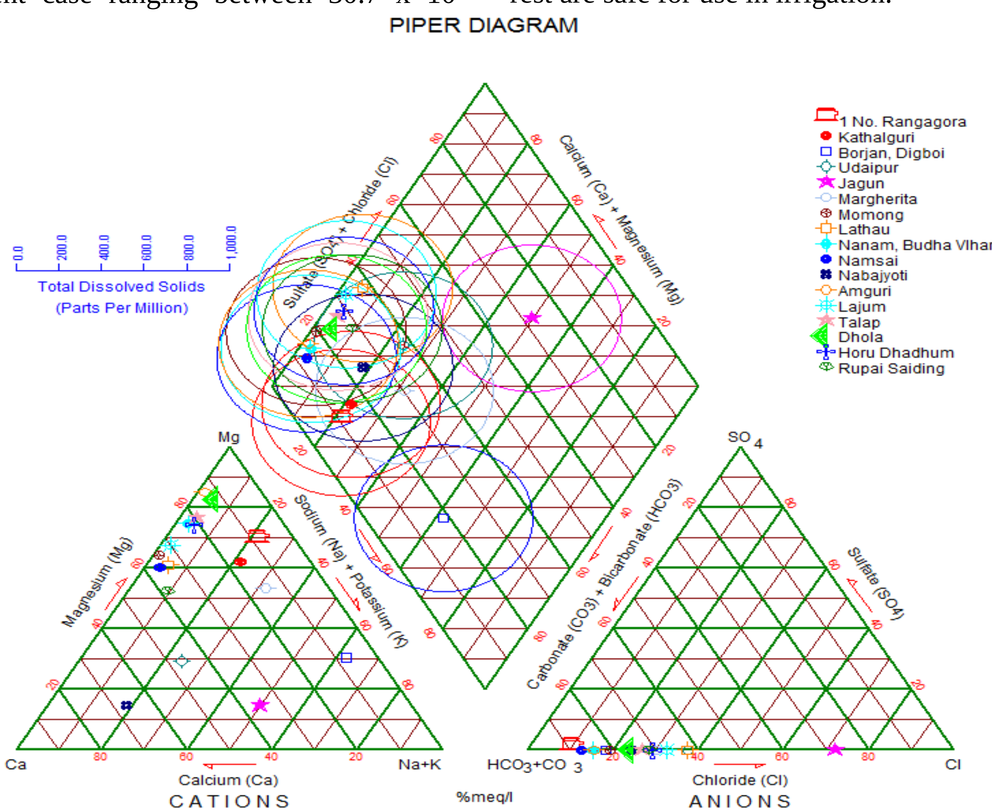


Fig 7: Piper Trilinear diagram showing Chemical character of groundwater of the study area

The graphical representation of the hydrochemistry of groundwater is evaluated by plotting the cations and anions in percent of total meq/l, in Piper's Trilinear diagram [9]. In the present study, the Piper's Trilinear diagram (**Fig 7**) reveals that the water of the area mostly belongs the Ca-Mg-HCO_3 facies while in the two localities viz. around Digboi and Margherita (Sl. Nos. 3 and 6) groundwater belongs to the Na-HCO_3 facies. The plot of the groundwater samples falls in the segments 1, 3 and 4 of the central diamond-shaped field, which suggest that alkaline earth exceeds alkalies and weak acids exceed strong acids respectively. Magnesium and calcium are the major cations while bicarbonate is the major anion in the study area. The plotting of the chemical quality data in the present study shows the dominance of magnesium and calcium bicarbonate. The predominance of Ca, Mg and HCO_3 indicate the temporary hardness, alkalinity and the total hydrochemistry dominated by alkaline earth and weak acids.

Classification of ground water is essential to make an assessment of its suitability for domestic, agricultural or industrial uses. Ground water of the present area of study is classified on the basis of total dissolved solids content as well as on the basis of concentration of Cl^-, HCO_3^- and Total Hardness [10, 11].

Total hardness denotes the concentration of calcium and magnesium in water. Usually expressed as equivalent of $CaCO_3$, it is calculated by the following formula [6, 7].

$$TH = 2.497\ Ca + 4.115\ Mg$$

The total hardness (as $CaCO_3$) value of ground water of the area ranges between 3.43 mg/l to 101.07 mg/l and it is observed that the ground water of the area are mostly soft in nature with moderately hard water occurring in two localities around Amguri (S. No. 12) and Dhola (S. No. 15).

Residual Sodium Carbonate measurements show that maximum water samples are moderately unsuitable (1 No. Rongagora, 2 No Kathalguri, Margherita etc.) for domestic use in the southern part of the terrain, whereas in the north-eastern part of the terrain water samples are also likely to be unsuitable for domestic purpose (Momong, Namam Budha Vihar, Namsai, Amguri etc.). However the chemical compositions of the water samples are suitable for irrigation purpose and are likely to be suitable for industrial usages.

The conductivity measurements shows that some water samples have relatively high values of ionic conductivity which is also reflected by the presence of comparatively large amount of ionic species (Jagun, Margherita, Amguri, Namsai, Nanam Budha Vihar etc.). This is quite possible as these samples are collected from spots near to human habitation and are also high lands not washed out regularly by river water.

Apart from four areas (viz. Jagun, Amguri, Talap and Haru dhadum) characterized by higher concentration of iron (ranging from 3.07 mg/l to 11.76 mg/l), groundwater from rest of the area are characterized by relatively low concentration of Fe which can be used for domestic purpose after simple method of aeration and filtration.

Table 1: Physical parameters of soil samples

Sample No.	Location	Particle density gm/ml	Bulk density gm/ml	Pore Space	Texture %			Water Permeability ml/hr
					Clay	Silt	Sand	
1	1 No Rongagora	2.00	1.11	44.44	28.14	30.49	41.33	1.324
2	2 No Kothalguri	1.82	1.11	38.89	18.30	13.51	68.16	3.3
3	Borjan, Digboi	2.00	1.11	55.55	16.59	14.12	69.13	13.59
4	Udaipur	1.66	1.00	40	24.72	38.2	21.45	4.59
5	Jagun	2.00	1.18	41.1	26.86	16.73	51.28	4.49
6	Margherita	2.22	1.11	50	35.75	25.96	38.25	0.71
7	Chowkham 2	2.60	1.63	37.5	2.08	6.65	83.95	6.31
8	Momong	2.17	1.30	40	8.65	10.94	64.69	8.72
9	Lathau	2.35	1.21	48.48	17.64	5.99	67.74	8.51
10	Nanam Budha Vihar	1.82	1.25	31.25	15.29	14.60	58.33	14.46
11	Namsai	2.26	1.45	36.11	15.24	11.29	48.24	7.43
12	Nabajyoti	1.86	1.30	30	4.9	9.3	68.69	4.31
13	Amguri	2.22	1.25	43.75	15.02	9.19	69.28	2.74
14	Lajum	1.82	1.33	26.6	11.83	1.60	84.23	5.22
15	Talap	1.60	1.18	15	24.29	9.9985	62.29	2.61
16	Dhola	2.36	1.11	31.67	24.29	38.48	37.78	1.33
17	Horu Dhadum	3.08	1.03	43.33	20.29	27.99	44.81	1.42

Table 2: Results of chemical analyses of soil samples.

Sample No.	Location	pH	Conductivity µs	Total soluble salt %	Loss on Ignition %	Acid insoluble %	Org. Carbon %	Ca %	Mg %	Fe %	Al %	Na %	K %
1	1 No Rongagora	6.65	65.1	1.24	6.47 at 568.33^{0}C	75.73	2.37	0.39	1.30	11.30	0.12	0.19	0.69
2	2 No Kothalguri	4.96	40.5	0.28	3.13 at 522.13^{0}C	87.40	1.37	0.39	1.30	5.82	0.04	0.22	0.49
3	Borjan, Digboi	4.90	21.0	0.23	4.58 at 565.33^{0}C	85.30	4.61	0.19	0.41	6.46	0.03	0.07	0.18
4	Udaipur	4.90	96.3	0.10	8.46 at 608.74^{0}C	74.90	4.56	0.24	0.58	7.02	0.064	0.09	0.20
5	Jagun	4.74	71.8	0.05	7.42 at 599.48^{0}C	76.50	2.12	0.01	4.31	17.05	0.13	0.29	0.68
6	Margherita	3.90	576.5	0.28	7.70 at 657.08^{0}C	77.51	3.12	0.81	0.76	11.99	0.19	0.18	0.54
7	Chowkham 2	5.95	52.6	0.32	2.79	84.38	1.99	0.16	0.23	8.34	1.61	0.06	0.06
8	Momong	6.74	65.7	0.16	3.65	81.63	0.69	0.73	0.11	10.54	2.50	0.04	0.14
9	Lathau	4.63	113	0.15	6.76	74.15	1.89	0.56	0.51	11.86	0.44	0.01	0.04
10	Nanam Budha Vihar	4.27	161.6	0.10	10.12	75.85	3.54	1.31	0.27	13.99	0.31	0.01	0.02
11	Namsai	4.47	13.4	0.26	5.40	83.60	1.56	0.66	0.37	6.59	2.00	0.02	0.06
12	Nabajyoti	6.48	3.8	0.94	2.67	85.31	0.49	0.89	0.50	7.54	2.83	0.20	0.05
13	Amguri	5.37	128.6	0.20	3.73	83.62	1.83	0.67	0.59	10.53	0.13	0.01	0.06
14	Lajum	4.91	248.2	0.35	2.99	85.21	1.46	8.19	0.48	10.53	0.13	0.02	0.05
15	Talap	4.70	182.6	0.29	2.59	81.25	.38	0.97	0.84	13.52	0.46	0.18	0.47
16	Dhola	5.44	102.6	0.27	3.05	70.84	3.41	1.24	0.85	11.99	0.55	0.21	0.71
17	Horu Dhadum	5.04	138.5	0.32	2.91	73.36	3.72	1.70	0.75	15.09	0.61	0.24	0.79

Table 3: Chemical analysis of soil samples of various depths from Drilled Well No.-1 at Dhola

Location: N 27˚45'16.4" & E 95˚37'17.9" Elevation: 113m

Sample No.	Depths In cm	Particle Densities gm/ml	Bulk Density gm/ml	Pore Space in %	pH	Loss on ignition in %	Acid insoluble in %	Ca %	Mg %	Na %	K%
1	656	2.727	1.875	31.25	5.31	0.4	87.78	1.18	0.9545	0.0086	0.0136
2	1439	2.727	1.579	42.105	6.06	0.3397	85.352	1.022	0.9545	0.0086	0.0109
3	2709	2.727	1.579	42.105	6.14	0.1999	84.08	0.3932	0.8112	0.0064	0.0088
4	4237	2.727	1.5	45.00	6.67	0.3197	89.79	0.708	0.429	0.0099	0.0148
5	5249	2.3076	1.579	31.579	6.64	0.3399	85.40	0.7864	0.859	0.0086	0.0157

Table 4: Chemical analysis of soil samples of various depths from Drilled Well No.-2 at Chota Tingrai

Location: N 27˚27'12.9" & E 95˚22'30.4" Elevation: 106.8m

Sample No.	Depths In cm	Particle Densities gm/ml	Bulk Density gm/ml	Pore Space in %	pH	Loss on ignition in %	Acid insoluble in %	Ca %	Mg %	Na %	K%
1	92	2.857	1.25	56.25	5.1	5.179	75.82	2.815	6.49	0.332	0.028
2	1140	2.5	1.33	46.66	7.13	0.918	90.38	3.942	4.613	0.121	0.013
3	2025	2.00	1.428	28.57	5.43	3.98	78.08	6.19	1.121	0.114	0.0087
4	3133	2.857	1.818	36.66	7.16	0.74	88.02	4.22	4.44	0.061	0.0065
5	4153	2.5	1.25	50	6.34	0.69	88.25	5.913	10.418	0.179	0.011
6	5122	4.00	2.0	50	6.84	0.98	88.38	7.039	2.733	0.139	0.0065

Table 5: Chemical analysis of soil samples of various depths from Drilled Well No.-3 at Naharkatia
Location: N 27˚16'49.8" & E 95˚18'57.6" Elevation:103.4m

Sample No.	Depths In cm	Particle Densities gm/ml	Bulk Density gm/ml	Pore Space in %	pH	Loss on ignition in %	Acid insoluble in %	Ca %	Mg %	Na %	K%
1	53	2.22	1.33	40	4.41	5.76	84.22	0.08	0.86	0.03	0.037
2	865	2.22	1.54	30.76	5.83	1.82	91.14	0.16	1.42	0.03	0.035
3	2835	3.33	1.54	53.85	6.34	1.82	90.80	0.20	0.81	0.036	0.031
4	5201	2.86	1.54	46.15	6.44	1.88	90.36	0.24	1.38	0.03	0.025

Table 6: Chemical analysis of soil samples of various depths from Drilled Well No.-4 at Doomdooma
Location: N 27˚32'43.0" & E 95˚32'36.1" Elevation:108.2m

Sample No.	Depths In cm	Particle Densities gm/ml	Bulk Density gm/ml	Pore Space in %	pH	Loss on ignition in %	Acid insoluble in %	Ca %	Mg %	Na %	K%
1	50	2.11	1.11	47.22	4.25	6.08	81.72	0.05	0.61	0.082	0.284
2	450	2.00	1.25	37.50	5.68	3.20	85.72	0.20	1.07	0.041	0.136
3	905	2.00	1.43	28.57	6.28	1.76	88.48	0.20	0.55	0.114	0.154
4	1805	1.82	1.11	38.88	6.41	1.84	91.58	0.30	0.64	0.073	0.118
5	3136	2.22	1.54	23.10	6.68	1.44	73.62	0.44	0.44	0.073	0.133
6	5200	2.22	1.25	37.50	6.92	6.72	69.82	0.40	1.23	0.241	0.52

Table 7: Results of chemical analyses of water samples

Sample No.	Location	pH	Conductivity (S)	TDS mg/l	Cl mg/l	CO_3 mg/l	HCO_3 mg/l	Ca g/l	Mg mg/l	Na g/l	K mg/l	Fe mg/l	RSC mg/l	SAR	Total Hardness as ($CaCO_3$ in mg/l
1	1 No Rongagora	6.46	127.3	150	12.25	70.56	269.01	389.46	063.52	5.57	1.75	0.56	2.26	468 x 10^{-3}	26.761
2	2 No Kothalguri	7.60	99.2	250	12.25	32.63	627.71	84.17	827.13	4.79	0.97	0.64	1.63	422 x 10^{-3}	24.326
3	Borjan, Digboi	7.42	71.3	250	8.20	21.19	197.28	7.90	119.52	3.57	2.22	0.80	0.82	838 x 10^{-3}	3.4339
4	Udaipur	7.34	79.9	200	20.50	5.29	789.12	553.10	361.17	5.01	0.87	0.78	1.27	420 x 10^{-3}	26.829
5	Jagun	7.22	407.3	400	2.02	3.53	789.12	895.55	597.55	33.93	6.31	3.07	0.19	1.89	60.941
6	Margherita	7.78	446.3	350	5.01	68.79	215.21	73.55	1299.67	13.43	1.26	0.40	1.89	932 x 10^{-3}	39.254
7	Momong	8.07	163.1	250	39.37	84.37	1368.63	570.26	1774.40	0.59	0.33	1.26	3.69	30.7 x 10^{-3}	68.624
8	Lathau	6.65	32.4	250	9.69	12.32	462.64	49.18	500.02	0.69	0.18	2.25	0.78	63.3 x 10^{-3}	19.649
9	Nanam Budha Vihar	7.48	171.1	150	27.89	75.84	1445.74	872.95	2318.45	0.86	2.22	2.57	3.48	44.2 x 10^{-3}	71.12
10	Namsai	7.84	177.7	100	1.33	57.83	1966.21	570.26	1577.24	1.37	0.83	1.02	3.86	74.2 x 10^{-3}	64.563
11	Nabajyoti	6.77	128.9	100	1.33	23.7	963.83	63.85	78.87	0.71	29.59	0.39	2.79	84.1 x 10^{-3}	13.656
12	Amguri	7.58	307.8	200	1.17	67.31	2197.52	648.26	3909.48	1.11	0.65	3.62	3.83	48.2 x 10^{-3}	101.07
13	Lajum	6.82	89.9	100	6.25	23.7	626.49	423.45	1181.94	0.54	0.52	2.01	0.98	36.4 x 10^{-3}	42.11
14	Talap	6.64	142.3	150	5.86	31.83	761.30	125.85	1639.91	1.47	0.18	4.09	1.36	92.8 x 10^{-3}	47.49
15	Dhola	6.94	436.8	400	1.79	69.30	932.72	125.85	3005.98	1.33	6.81	1.15	1.54	66.5 x 10^{-3}	75.949
16	Horu Dhadum	8.15	59.4	100	4.19	35.58	989.45	576.35	2049.95	1.43	2.29	11.76	1.57	134 x 10^{-3}	61.891
17	Rupai Saiding	8.67	280	200	41.79	63.66	485.57	1351.10	83.40	1.47	2.022	1.84	2.30	115 x 10^{-3}	30.938

CONCLUDING REMARKS

The area of investigation is a flood plain with thick succession of alluvial deposits and the geochemical characteristics of subsurface soil and groundwater is mainly the signature of natural events and geological formation rather than anthropogenic activities, which are limited to agricultural activities. The properties of the soils are mainly controlled by the deposition of sediments carried by Noa Dihing and Burhi Dihing rivers originated from the Patkai hill ranges. In the area near Noa Dihing river, the relative permeability of the soil is higher, of sandy loam type indicating easy recharge of the aquifers . The organic rich subsurface soils near Burhi Dihing river has more clay but less amount of ionic concentration and less porous. The area is also thickly populated with good agricultural practices. The sediments deposited by Brahmaputra may also contribute towards the overall geochemical characteristics of the soil. Apart from four locality (viz., Jagun, Amguri, Talap and Horudhadum) characterized by higher concentration of iron (3.07 mg/l to 11.76 mg/l), the groundwater from rest of the area are suitable for domestic purposes with relatively low iron concentration.

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